

## Claims

- [c1] 1. A soft hybrid-electric vehicle power supply circuit for a soft hybrid-electric vehicle comprising:
- a load sensor generating a load signal;
  - a high-voltage bus supplying a high voltage for a high-voltage load;
  - a low-voltage bus electrically coupled to and supplying a low-voltage to a low-voltage load; and
  - a converter circuit electrically coupled to said high-voltage bus, said low-voltage bus, and said high voltage load, said converter circuit maintaining a predetermined minimum voltage level on said high-voltage load by switching between said high-voltage bus and said low-voltage bus in response to said load signal.
- [c2] 2. A circuit as in claim 1 further comprising an integrated starter generator supplying power to said high-voltage bus or an engine.
- [c3] 3. A circuit as in claim 2 further comprising:
- an integrated starter generator control circuit electrically coupled to said integrated starter generator and said high-voltage bus, said integrated starter generator control circuit signaling said integrated starter generator in response to said load signal.
- [c4] 4. A circuit as in claim 3 wherein said integrated starter generator control circuit comprises:
- an inverter processing electrical power between said high-voltage bus and said integrated starter generator; and
  - an integrated starter generator controller electrically coupled to said inverter and determining when to process said electrical power.
- [c5] 5. A circuit as in claim 1 wherein said converter circuit comprises:
- a bi-directional switch; and
  - a bi-directional converter electrically coupled to said bi-directional switch and controlling said bi-directional switch, said bi-directional converter controlling direction of voltage conversion from either said high-voltage bus to said low-voltage bus or from said low-voltage bus to said high-voltage bus to maintain

said predetermined minimum voltage level on said high-voltage load.

- [c6] 6. A circuit as in claim 1 further comprising a high-voltage energy storage device electrically coupled to and supplying power to said high-voltage bus.
- [c7] 7. A circuit as in claim 1 further comprising a low-voltage energy storage device electrically coupled to and supplying power to said low-voltage bus.
- [c8] 8. A circuit as in claim 1 wherein said converter circuit maintains said predetermined minimum voltage level during soft hybrid-electric vehicle engine high-loading periods.
- [c9] 9. A circuit as in claim 1 wherein said predetermined minimum voltage level is approximately 30 volts.
- [c10] 10. A soft hybrid-electric vehicle power supply system for a soft hybrid-electric vehicle comprising:  
a engine propelling the soft hybrid electric vehicle;  
an engine controller determining the status of said engine and generating a load signal;  
a soft hybrid-electric vehicle power supply circuit comprising;  
a high-voltage bus supplying a high voltage for a high-voltage load;  
a low-voltage bus electrically coupled to and supplying a low-voltage to a low-voltage load; and  
a converter circuit electrically coupled to said high-voltage bus, said low-voltage bus, and said high voltage load, said converter circuit maintaining a predetermined minimum voltage level on said high-voltage load by switching between said high-voltage bus and said low-voltage bus in response to said load signal;  
said converter circuit generating a converter circuit status signal upon switching voltage supply for said high-voltage load;  
said engine controller signaling said engine to draw power from said high-voltage bus in response to said converter circuit status signal.
- [c11] 11. A system as in claim 10 further comprising an integrated starter generator supplying power to said high-voltage bus or said engine.

- [c12] 12. A system as in claim 11 further comprising an integrated starter generator control circuit electrically coupled to said integrated starter generator and said high-voltage bus, said integrated starter generator control circuit adjusting performance of said integrated starter generator.
- [c13] 13. A system as in claim 12 wherein said integrated starter generator control circuit comprises:  
an inverter processing electrical power between said high-voltage bus and said integrated starter generator; and  
an integrated starter generator controller electrically coupled to said inverter and determining when to process said electrical power.
- [c14] 14. A system as in claim 10 wherein said converter circuit comprises:  
a bi-directional switch; and  
a bi-directional converter electrically coupled to said bi-directional switch and controlling said bi-directional switch, said bi-directional converter controlling direction of voltage conversion from either said high-voltage bus to said low-voltage bus or from said low-voltage bus to said high-voltage bus to maintain said predetermined minimum voltage level on said high-voltage load.
- [c15] 15. A system as in claim 10 further comprising a high-voltage energy storage device electrically coupled to and supplying power to said high-voltage bus.
- [c16] 16. A system as in claim 10 further comprising a low-voltage energy storage device electrically coupled to and supplying power to said low-voltage bus.
- [c17] 17. A system as in claim 10 wherein said converter circuit maintains said predetermined minimum voltage level during soft hybrid-electric vehicle engine high-loading periods.
- [c18] 18. A system as in claim 10 wherein said predetermined minimum voltage level is approximately 30 volts.
- [c19] 19. A method of maintaining a predetermined minimum voltage level on a high-voltage load for a soft hybrid-electric vehicle comprising:  
generating a load signal;

performing a high-voltage mode when said load signal is greater than a predetermined load and generating a first direction signal and performing a low-voltage mode when said load signal is less than or equal to a predetermined load and generating a second direction signal; switching a bi-directional switch to a open state in response to said first direction signal and to a closed state in response to a second direction signal; and performing an up-conversion in response to said first direction signal and a down-conversion in response to said second direction signal to maintain a predetermined minimum voltage level on the high-voltage load.

[c20] 20. A method as in claim 19 wherein performing an up-conversion and a down-conversion comprises:

determining time to perform a voltage conversion;  
determining a power rating for said voltage conversion; and  
determining a duration of time to perform said voltage conversion.

[c21] 21. A method as in claim 19 wherein switching said bi-directional switch and performing said voltage conversion comprises:

decoupling a high-voltage load from said high-voltage bus and coupling said high-voltage load to a low-voltage bus during soft hybrid-electric vehicle engine high-loading periods; and  
coupling said high-voltage load to said high-voltage bus and decoupling said high-voltage load from said low-voltage bus during normal-loading periods.

[c22] 22. A method as in claim 19 further comprising initiating a high-loading mode on a converting circuit before executing said high-loading mode on an integrated starter generator.